

# (12) UK Patent Application (19) GB (11) 2 318 483 (13) A

(43) Date of A Publication 22.04.1998

(21) Application No 9621787.2

(22) Date of Filing 18.10.1996

(71) Applicant(s)

**Motorola Limited**

(Incorporated in the United Kingdom)

**Jays Close, Viables Industrial Estate, Basingstoke,  
Hampshire, RG22 4PD, United Kingdom**

(72) Inventor(s)

**Paul Crichton**

(74) Agent and/or Address for Service

**Marc Morgan**

**Motorola Limited, European Intellectual Property  
Operation, Midpoint, Alencon Link, BASINGSTOKE,  
Hampshire, RG21 7PL, United Kingdom**

(51) INT. CL.<sup>6</sup>

**H04Q 7/38**

(52) UK CL (Edition P)

**H4L LDSG L1H10**

(56) Documents Cited

**GB 2289916 A**

**EP 0731822 A2**

**EP 0637895 A2**

**EP 0615395 A1**

**EP 0610645 A1**

**WO 94/00959 A1**

**US 5428817 A**

(58) Field of Search

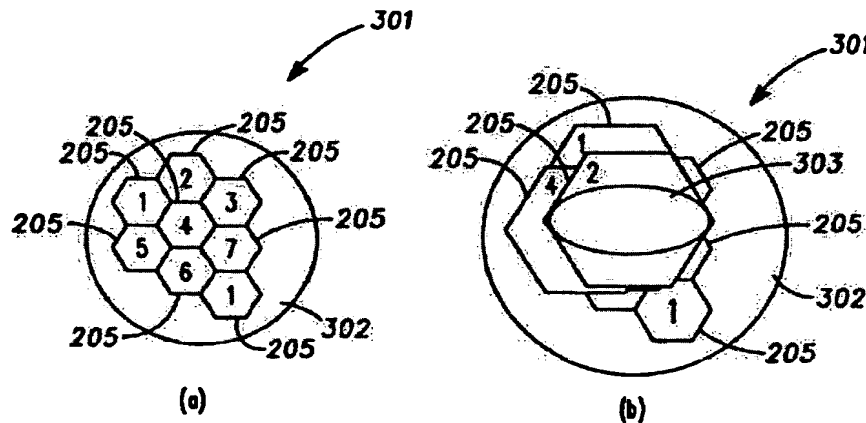
**UK CL (Edition N) H4L LDSE LDSG**

**INT. CL.<sup>6</sup> H04Q 7/38**

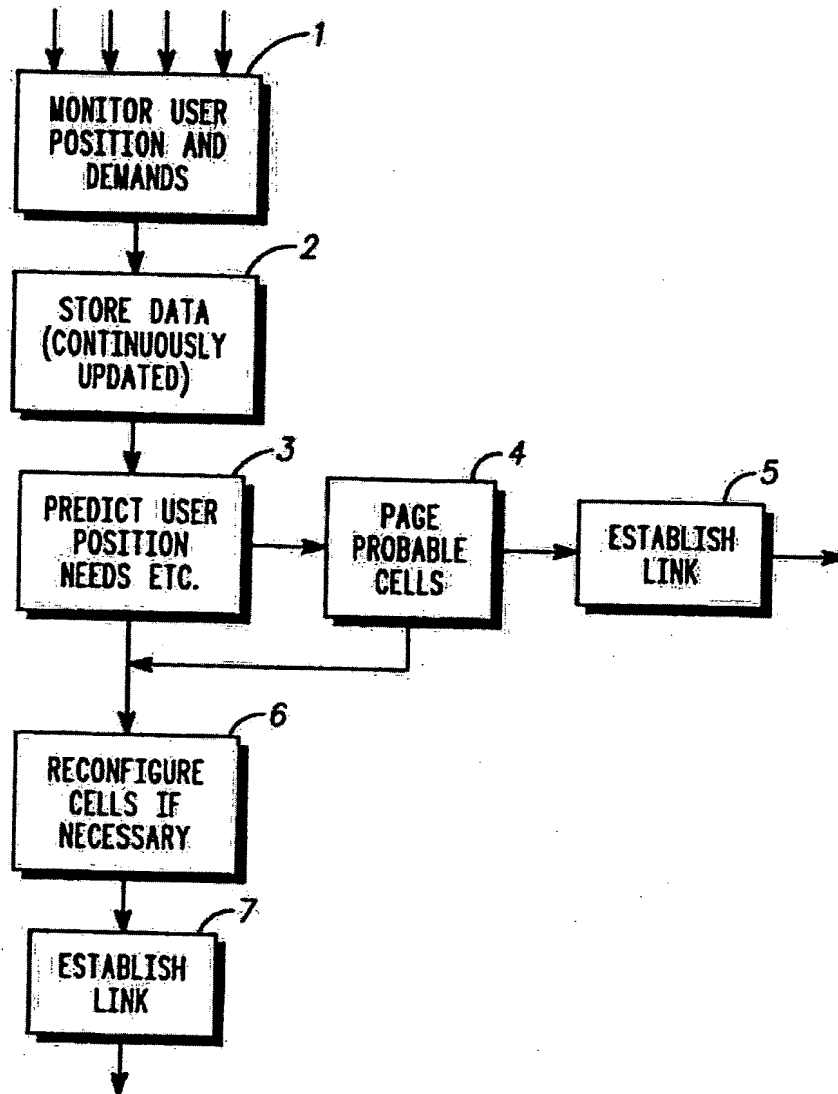
**ONLINE: WPI**

## (54) Dynamic Control of Cellular Radio Communication System Resources

(57) A method of optimising the operation of a cellular radio communication system in which the demands made by users of the system are monitored and resources are allocated to the users accordingly. In particular cell sizes and numbers of channels allocated to cells may be varied. The invention is described with reference to a personal cellular system in which a central transceiver unit (202) communicates with a plurality of subsidiary units (203) each serving as a base station for a single user station (204).



**FIG. 3**

*FIG. 1*

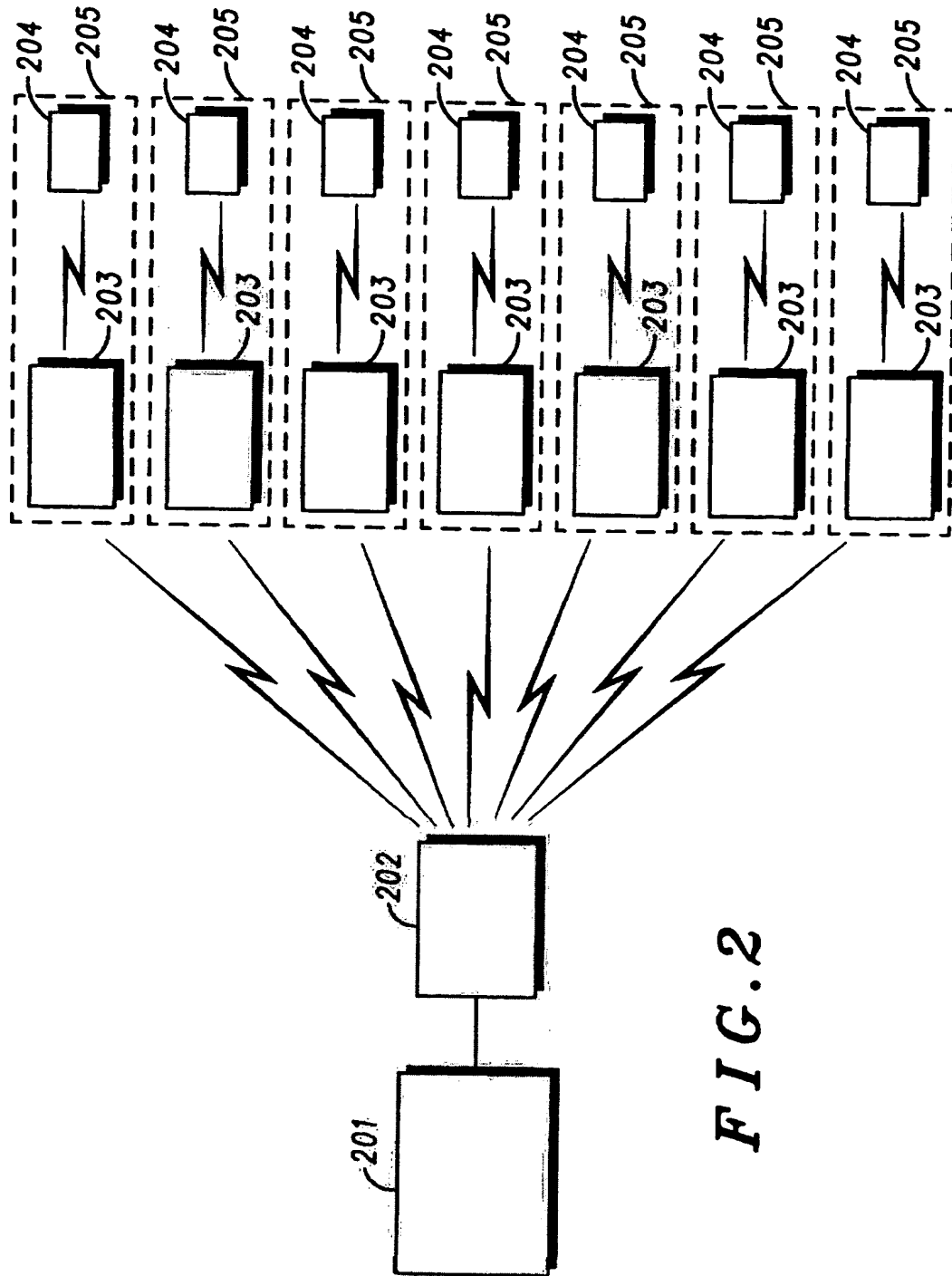


FIG. 2

**Dynamic Control of Cellular Radio Communication System Resources.****Field of the Invention**

5           The present invention relates to cellular radio communication systems.

**Background of the Invention**

10           Cellular radio communication systems consist of a base transceiver station which communicates with a number of, usually mobile, subsidiary transceiver stations with an area surrounding the base station and constituting a cell of the system.

15           Conventionally, cellular radio communication systems are categorized as macrocell, microcell or pico cell according to the nominal radius of the cells constituting the system. Macrocell systems have cells with radius of over 1 km, microcell systems have cells with radius in the range of 100m to 1 km and picocell systems have cell radius in the range 30m to 100m. A form of cellular radio communication system with a  
20           still smaller cell size is coming into use and has been given the designation "personal". Such systems have cell radius less than 30m, and typically less than 3m. A few personal cells may be considered together as a "group" cell.

25           In personal/groups cells the usage of individuals resources levels (area used over time, frequencies used, cell size, bandwidth allocated, and services) and interference are monitored by the system. This information may then be used to optimise the performance of the system (capacity level, resource usage, power).

30           In macro, micro and pico cell systems, the nominal sizes of the cells and the frequencies upon which the base stations operate are determined during the initial setting up and commissioning of the system concerned.

35           In personal cellular radio communication systems on the other hand, the cell size and its characteristic frequency may be assigned to a specific user of the system and not to a base station in a fixed location.

### Summary of the Invention

5 The present invention, although applicable to all types of cellular radio communication systems, is particularly useful in connection with personal cellular radio communication systems.

10 According to the present invention there is provided a method of optimising the operation of a cellular radio communication system, including the operations of monitoring the positions of services used and frequency of calls made by user stations within cells in a region of the cellular radio communication, establishing a dynamic user profile data base related thereto, and varying the characteristics of the cells in the said region of the radio communication system in response to data  
15 derived from the user profile data base so as to allocate resources to the cells as a function of the demands made by the user stations within the cells. The word "dynamic" is used to indicate that the information in the data base is updated regularly.

20 The said resources may include the sizes of the cells and/or the number of traffic channels and available within the cells. Preferably there is included also the operations of monitoring the level of interference within the cells in the said region of the cellular communication system, producing an interference probability  
25 distribution function related thereto, and routing calls to avoid those cells in which the levels of interference are highest.

30 There may be included also the operations of producing a location probability distribution function for specific users of the system can be routed initially to those cells where experience has shown that they are most likely to be. Also, the handover sequences for those cells can be recorded in the user profile data base so that they can be initiated at the same time that a request for service is received by the base transceiver station of the cell concerned.

35

The above operations are applicable particularly in the case of the smallest cell size systems (pico and personal) because most users of

such systems tend to remain in well defined positions, or to move only locally.

Also according to the invention there is provided a cellular radio  
5 communication system wherein there is provided a base service  
transceiver station, serving a region of the cellular radio  
communication system, a central transceiver station in communication  
with the base service station, a plurality of subsidiary transceiver units  
in communication with the central transceiver station and a user  
10 station in communication with an associated subsidiary transceiver, to  
form a cell of the cellular radio communication system, wherein the  
base service transceiver station includes a central processing unit  
adapted to monitor continuously the positions of, services used and  
frequency of calls made by the user stations in the said region of the  
15 cellular radio communication system at regular intervals store data  
relating thereto in a user profile data store and produce operating  
signals adapted to cause the central transceiver station to vary the  
characteristics of the cells in the said region of the cellular radio  
communication system in response to the operating signals so as to  
20 allocate resources to the cells as a function of the demands made by the  
user stations within the cells of the cellular radio communication  
system.

#### Brief Description of the Drawings

25 The invention will now be described, by way of example, with reference  
to the accompanying drawings.

Figure 1 is a flow chart of a system embodying the invention for  
optimising the operation of a cellular radio communication system.

30

Figure 2 shows, schematically, the layout of a personal cell size  
cellular radio communication system, and

Figure 3 shows how the system of figure 2 can react to  
35 accommodate changes in the distribution of users of the system within a  
region of the system.

### Detailed Description of a Preferred Embodiment

Referring to Figure 1, the traffic within a region of a cellular radio communication system is monitored continuously by a base service station (not shown) for that region of the cellular radio communication system (also not shown). The base service station monitors the positions of users of the radio communication system, the services they request, the frequency requested and that actually used. Also monitored continuously for the cells within the region served by the base service station are the signal to interference ratios of the traffic channels used, the signal strengths and the number of requests for alternative traffic channels made by users of the cellular radio communication system (stage 1). This information is stored in a user profile data base which is updated at regular intervals (stage 2). Information is extracted from the store and used to predict the probable location of one or more users of the system, the carrier requirements and the most appropriate frequencies to be used (Stage 3). This data is used to reconfigure the cell, or cells, the user or users of the system and possibly to page the cell or cells in which the user or users of the system are most likely to be found. (stage 4 and 5) contact having been made communication links are established in the usual way. (Stages 6 and 7).

Once sufficient information has been collected concerning the whole population of users, the optimum frequency allocation and cell sizes for the system can be determined. As the system develops this allocation can be adopted to meet any new requirements.

One possible use of the information would be to modify the size of cells to decrease the trunking loss of a personal cell radio communications system, as illustrated in Figure 3.

Figure 2 shows a conceptual personal radio cellular communication system embodying the invention. Referring to Figure 2, a base service station 201, in which the above described operations are carried out, communicates with a central transceiver station 202. The central transceiver station 202 in turn communicates with a network of subsidiary transceiver units 203, each of which form the base

transceiver station serving a single user station 204 in a cell 205 of the personal cellular radio communication system. The central transceiver station 202 is so positioned that communication with the subsidiary transceiver units 203 is supportable by an RF channel and the subsidiary transceiver units 203 are so positioned as to have communication with their respective user stations 204 which is supportable also by an RF channel. Other than RF frequencies can be used to communication between the central transceiver station 202 and the subsidiary transceiver units 203, and between them and the user stations 204, also, the central transceiver station 202 can be linked to the subsidiary transceiver units 203 by land line.

Figure 3 illustrates the reaction of the base service station 201 of such a system in response to the movement of one or more user station 204 from its normal position. referring to Figure 3 at (a) there is shown a region 301 of a cellular radio communication system such as that described with reference to Figure 2 in which there is a cell re-use pattern of seven cells 205. Also, there is an overlay cell 302 which is used to carry signals which are common to all the cells in the region 301 of the cellular radio communication system. Initially, the identity and usage status of all the user stations 204. (Not shown in the figure) in the region 301 of the cellular radio communication system is known by the base service station 201. Figure 3 shows one way which the base service station 201 can deal with the situation when three of the user stations 204. Those of cells 1, 2 and 4 move away from their normal positions and congregate in an area 303.

The base service station 201 causes the respective subsidiary transceiver unit 203 to increase their power output so that the size of their associated cells (1, 2 & 4) increases and an overlap region is created which encompasses the area 303 in which the user stations of the cells 1, 2 and 4 have congregated. A consequent loss of traffic carrying capacity occurs and this is rectified by increasing the area of the overlay cell 303 and passing some of the traffic through it.

If one of the user stations 204 begins to become mobil within its cell 205 then the base service station 201 can cause th size of that cell 205, to be



increased to allow for the increased mobility of the mobile user station 204, so delaying the need for handover to an adjacent cell 205. When this becomes necessary, the power level of the base transceiver station of the first cell 205 can be reduced, so conserving power and reducing interference.

The new cell 205 can either operate on the same frequency as the original cell 205 (i.e. the frequency associated with the identified user station 204 of that cell or the frequency associated with the user station 204 of the new cell 205. If the same frequency is used then the separation of the antennas associated with the subsidiary transceiver unit 203 forming the base stations of the two cells can be used to provide spatial diversity.

## Claims

1.       A method of optimising the operation of a cellular radio communication system, including the operations of monitoring the positions of services used and frequency of calls made by user stations within cells in a region of the cellular radio communication, establishing a dynamic user profile data base related thereto, and varying the characteristics of the cells in the said region of the radio communication system in response to data derived from the user profile data base so as to allocate resources to the cells as a function of the demands made by the user stations within the cells.
2.       A method according to claim 1 wherein there is included the operations of monitoring the level of interference within the cells in the said region of the cellular radio communication system, producing an interference probability distribution function related thereto and routing calls to avoid those cells in which the level of interference is highest.
3.       A method according to claim 1 or claim 2 wherein there is included the operations of producing a location probability distribution function for specific users of the cellular radio communication system, and initially routing incoming calls for those users of the system to cells where the probability distribution function indicates they are most likely to be.
4.       A method according to claim 3 wherein handover sequences for the above cells are recorded in the user profile data base and there is included the operation of initiating handover simultaneously with the reception by a base transceiver station of the cells concerned of a request for service involving a specified user of the system in those cells
5.       A method according to any of claims 1 to 4 wherein there is included the operation of determining from data held in the user profile data base the optimum allocation of radio frequency and size of cell for individual users of the cellular radio communication system

6. A method according to any preceding claim wherein there is included the operation of modifying the size of a particular cell of the system in response to information derived from the user profile data store relating to a movement of the specified user of the system associated with that cell.

7. A method according to any preceding claim including the operation of determining when a particular cell is not in use and reducing the power output of the base transceiver unit of that cell during the period for which the cell is unused.

8. A cellular radio communication system wherein there is provided a base service transceiver station, serving a region of the cellular radio communication system, a central transceiver station in communication with the base service station, a plurality of subsidiary transceiver units in communication with the central transceiver station and a user station in communication with an associated subsidiary transceiver, to form a cell of the cellular radio communication system, wherein the base service transceiver station includes a central processing unit adapted to monitor continuously the positions of, services used and frequency of calls made by the user stations in the said region of the cellular radio communication system at regular intervals store data relating thereto in a user profile data store and produce operating signals adapted to cause the central transceiver station to vary the characteristics of the cells in the said region of the cellular radio communication system in response to the operating signals so as to allocate resources to the cells as a function of the demands made by the user stations within the cells of the cellular radio communication system.

9. A cellular radio communication system wherein the operating signals produced by the base service transceiver station cause the central transceiver station to vary the size of/and the number of traffic channels available within the cells of the region of the cellular radio communication system.

10.       A cellular radio communication system according to claim 8 or claim 9 whereas the central control transceiver station communicates with the subsidiary transceiver units via radio frequency links.
- 5    11.       A cellular radio communication system according to claim 8 or claim 9 whereas the central transceiver station is linked to the subsidiary transceiver units by land lines.
- 10   12.       A cellular radio communication system according to any of claims 8 to 11 wherein a single user station is associated with a subsidiary transceiver unit to form a personal cell within the radio communication system.
- 15   13.       A cellular radio communication system according to claim 12 wherein a number of contiguous personal cells are encompassed by an overlay cell and communications between the central transceiver station the cells with the overlay cell are passed through the overlay cell.
- 20   14.       A cellular radio communication system according to claim 12 or claim 13 wherein there is included a facility for amalgamating personal cells to form a group cell.
- 25   15.       A method of optimising the operation of a cellular radio communication system substantially as hereinbefore described and with reference to the accompanying drawings.
16.       A cellular radio communication system substantially as hereinbefore described and with reference to the accompanying drawings.



# The Patent Office



Application No: GB 9621787.2  
Claims searched: all

Examiner: Nigel Hall  
Date of search: 8 January 1997

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.O): H4L (LDSE, LDSE)

Int CI (Ed.6): H04Q 7/36

Other: Online: WPI

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2299916 A (HITACHI) See abstract	1,8,9 at least
X	EP 0731622 A2 (AT&T IPM) See claim 1	"
X	EP 0637895 A2 (MOTOROLA) See abstract	"
X	EP 0615395 A1 (HITACHI) See abstract	"
X	EP 0610645 A1 (TELEVERKET) See abstract	"
X	WO 94/00959 A1 (NOKIA) See abstract	"
X	US 5428817 (NEC) See claims 7 and 9	"

The documents cited are examples only

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

